Space Weather Technical Forecast

Issued on Tuesday, 04 October 2022 at 13:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1/Minor storms possible, mainly Day 1. Ongoing likelihood of M-class flares with slight chance of isolated X-class flares due to AR3110 and AR3112.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate in the past 24 hours, with multiple M1-4 class flares from AR3112 and AR3110. There are currently seven numbered sunspot regions on the visible disc. AR3110 and AR3113 in the northwest have intertwining magnetic fields. AR3112 remains a large and longitudinally wide area in the northeast, with a complex magnetic field and a delta region in the centre. The remaining spots show little evidence of flares.

Two CMEs were observed directed to the northwest following M4 and M1 flares from AR3110 during the 3rd, both modelled to be missing ahead of Earth. Another CME from a filament eruption in the southeast late on the 2nd has a very slight chance of glancing Earth early day 3 (6th). However, this is low confidence, and any significant impacts are considered unlikely.

Solar Wind / Geomagnetic Activity: Solar wind parameters at L1, as measured by DSCOVR/ACE, and BGS magnetometers have indicated the possible arrival of two glancing CME's embedded within a HSS, likely from CH28/+ or CH30/+. Solar wind speeds have become elevated, on a rising trend, from around 470 km/s to 560 km/s. Density rose from below average to slightly above average after 03/2000 UTC. The total IMF, Bt, was mostly weak to moderate, but briefly strong (15nT) between 03/1830-1930 UTC. The north-south component, Bz, flucuated between +12/-13nT. The phi angle was mostly positive (away from the Sun) with brief periods of negative (toward the sun). The resultant geomagnetic activity was mainly Quiet to Active (Kp 2-4), but with two G1/Minor Storm (Kp 5) intervals.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, has trended from slightly above background, back down to background levels recently. High energy electron flux (greater than 2 MeV) was at background to moderate levels. The associated 24-hour fluence remained well below the Active (1e8 integrated pfu) threshold, but on a rising trend. Observed fluence at 04/0001 UTC was 6.14e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Moderate, with a chance of High levels, due to likely further M-flares or perhaps X-flares possible from AR3110 and AR3112.

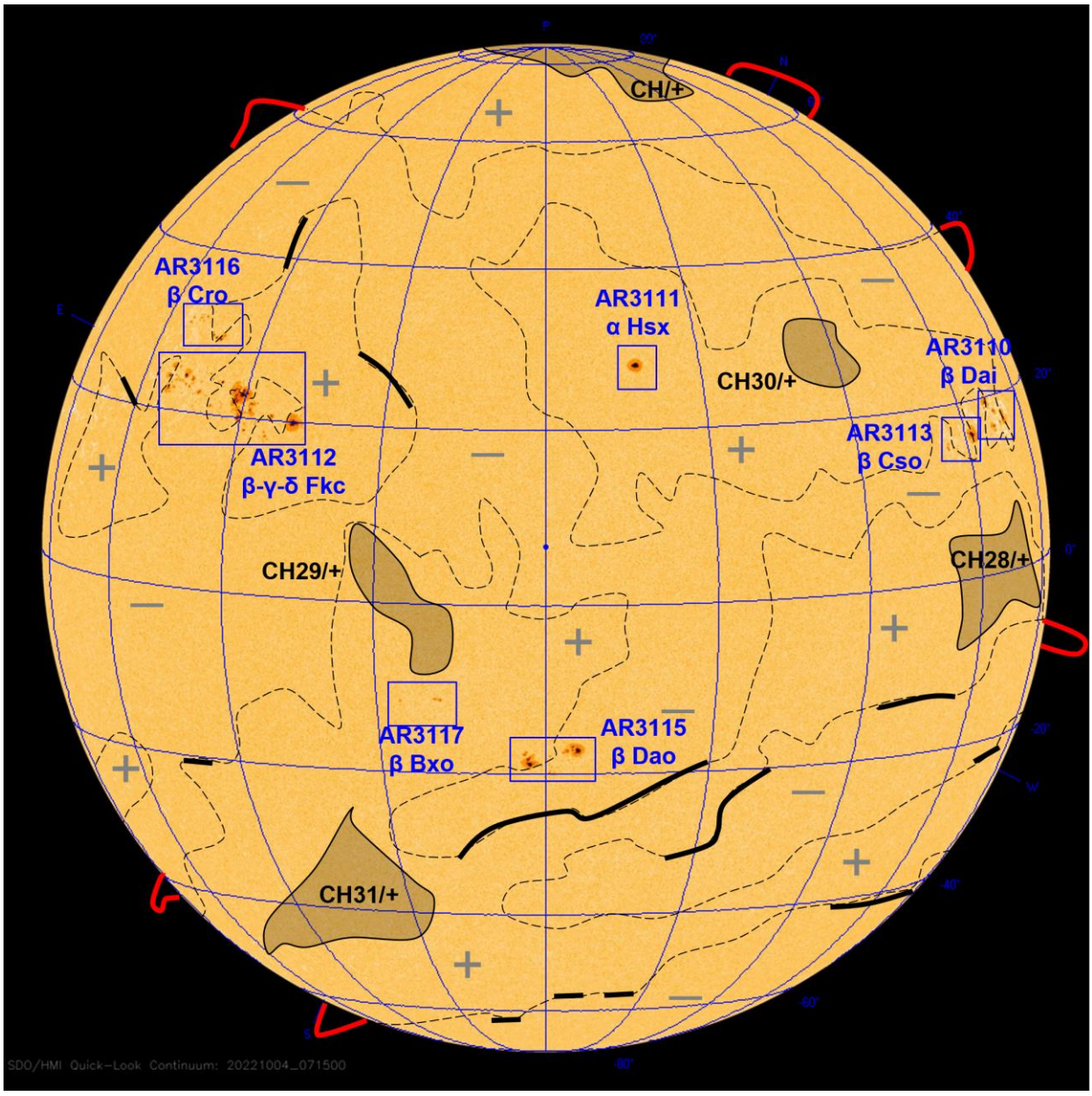
Solar Wind / Geomagnetic Activity: There is a chance of further CME glancing blows to occur on day 1 (4th). Solar winds are elevated due to a combination of HSS and CME arrivals, these are expected to follow a decreasing trend in coming days, bar a slight chance of a CME glancing blow early on 6th. Geomagnetic activity is forecast to be mainly Unsettled to Active (Kp 3-4) day 1 (4th) with a chance of further G1/Minor storms (Kp 5) due to any further CME influences. Otherwise, a general trend back towards Quiet to Unsettled (Kp 0-3) is likely through the period.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) is expected to be near background for much of the period, but with a slight chance of rising above the S1 level through the period due to any further M or X-flares that occur, mainly from AR3110 or AR3112. The high energy (greater than 2MeV) electron flux is likely to rise due to the recent elevated winds. This may occur later day 1 and through the rest of the period, with an increasing chance of flux becoming persistently High. However, this is uncertain due to the recent and potential CME impacts, with any rise likely occurring once their influence subsides. The associated 24 hour fluence will likely stay below the Active threshold until at least day 3 (6th), but with an increasing chance of rising above.

Figure 1. Solar Analysis Valid 04/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Geomagnetic Storms:

Multiple CMEs have erupted from the northwest quadrant in recent days, the most recent two following M4 and M1 flares from AR3110 on the 3rd. The first of these was modelled and is a clear miss ahead of Earths orbit. The second followed a near identical trajectory and was narrower, and is also assessed as being well off the Sun-Earth line.

Prior to these, four CMEs from the northwest were considered as having the potential for Earth-directed ejecta, although with low confidence. The most likely to impact originated from a filament eruption to the east of AR3113 at 01/1200 UTC. Two further CMEs from AR3110 associated the M5.8 and M8.3 flares at 01/2010 and 02/0220 UTC were mainly directed away from Earth, however these have a chance to give glancing impacts. A further CME from the X1.0 of AR3110 at 02/2025 UTC was analysed missing Earth. Another CME from a filament eruption in the southeast late on the 2nd has been analysed, and has a slight chance of glancing Earth day 3 (6th). However, this is low confidence, and any significant impacts are considered very unlikely.

According to BGS Magnetometers, it is thought that two CME impacts may be embedded in the current high speed stream. The first arrived around 03/2000 UTC and the second around 04/0530UTC. These corresponded with periods of G1/Minor storming in the subsequent periods. There remains a diminishing chance that further enhancements may occur later on 4th Oct.

Earth has been in the fast wind of CH28, with slightly elevated or elevated solar winds likely to persist into day 3 (6th), with some contribution also likely from CH30/+. There remains a great deal of uncertainty due to the low confidence surrounding CME arrival times and impacts.

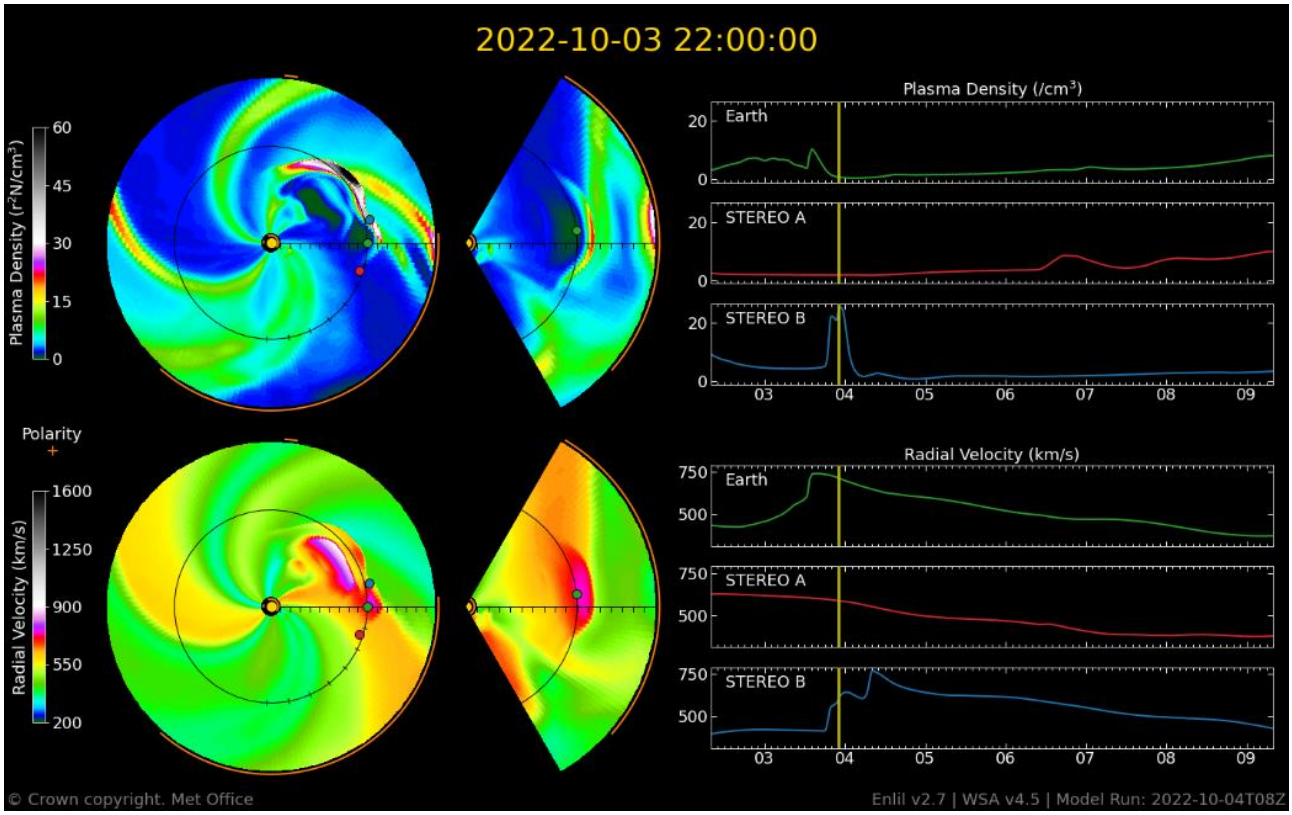
Geomagnetic activity is forecast to be mainly Unsettled to Active day 1 (4th) with a chance of further G1/Minor Storms, especially with any CME influences. Otherwise, a general trend back towards Quiet to Unsettled is likely through the period, with a slight increase possible on 6th should the CME from 2nd give a glancing blow.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	40	15	20	5
Strong	G3	No	5	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC ENLIL

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

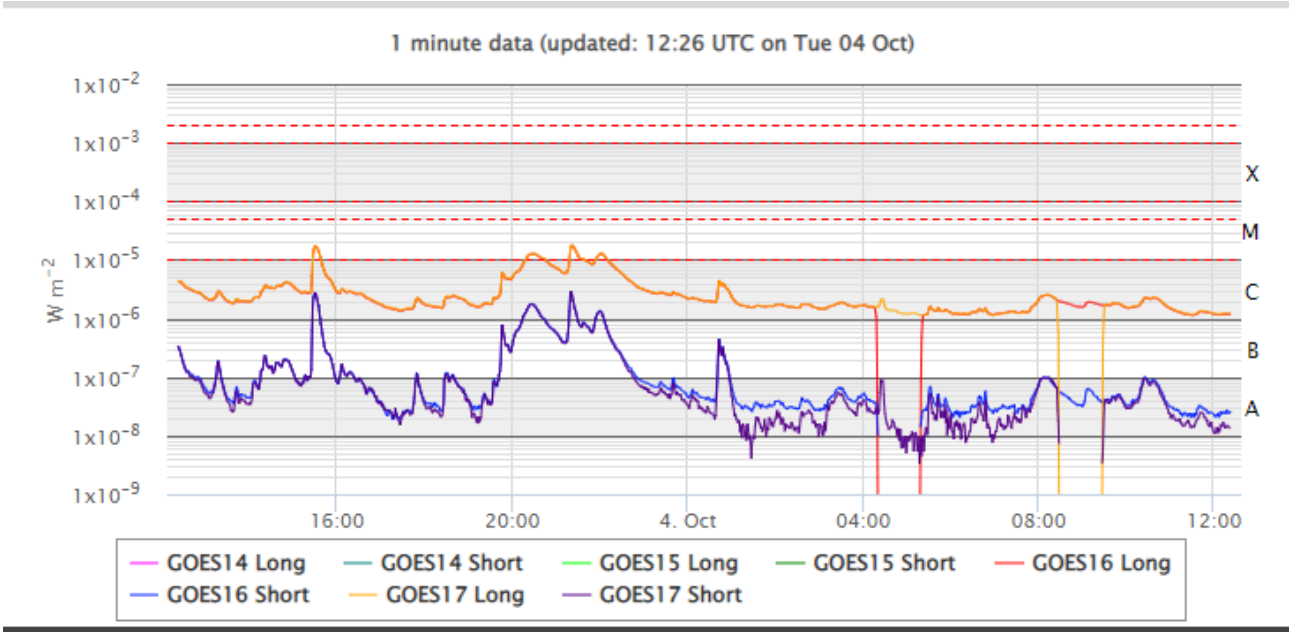
Radio Blackouts - X-Ray Flares:

There are currently seven numbered sunspot regions on the visible disc. AR3110 nearing the NW limb appears to be continuing a slowly decaying trend. Nearby AR3113 just to the east is showing little change. By far the largest region on the disk is AR3112, a longitudinally wide area in the northeast, with a complex magnetic field. The trailing part appears to be continuing to weaken, but its intermediate portion remains large and complex, with a delta configuration. AR3115 in the southern hemisphere near the meridian has continued to grow, with a distinct leader and trailer portion, both with mature penumbra. Other spot groups are simple and smaller with little recent change.

Solar activity seems to be on a downward trend, but has been Moderate in the past 24 hours, with multiple M1-4 class flares from AR3112 and AR3110. Further M-flares are expected, with a slight chance of isolated X-class flares from AR3110 or AR3112.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	70	70	60	60
Very Active	R3 to R5 X Class	No	20	20	15	15

Figure 3: Xray trace past 24 hrs.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

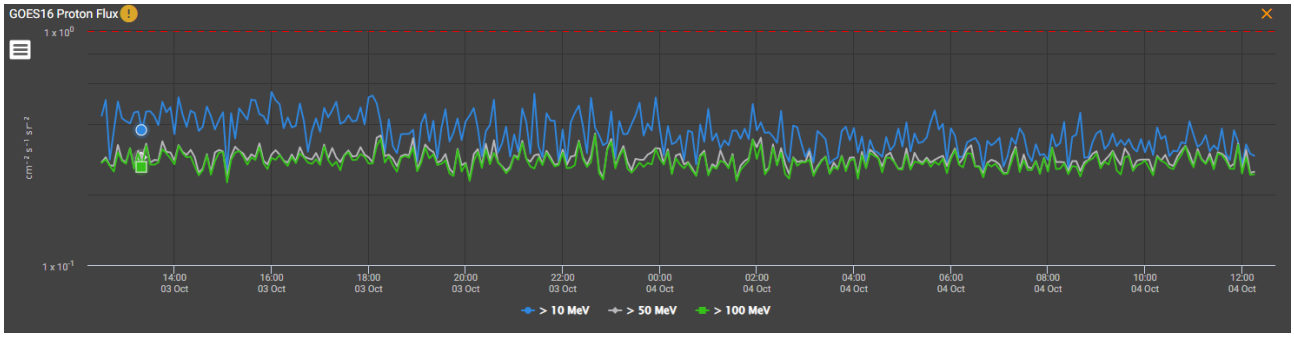
© Crown Copyright 2022. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) as observed by GOES16 has fallen back to background levels. There is a slight chance of exceeding the S1 threshold, primarily from any further M or X-flares from AR3110, but potentially also from AR3112 in the northeast given a sufficiently strong flare event.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Proton trace past 24 hrs.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

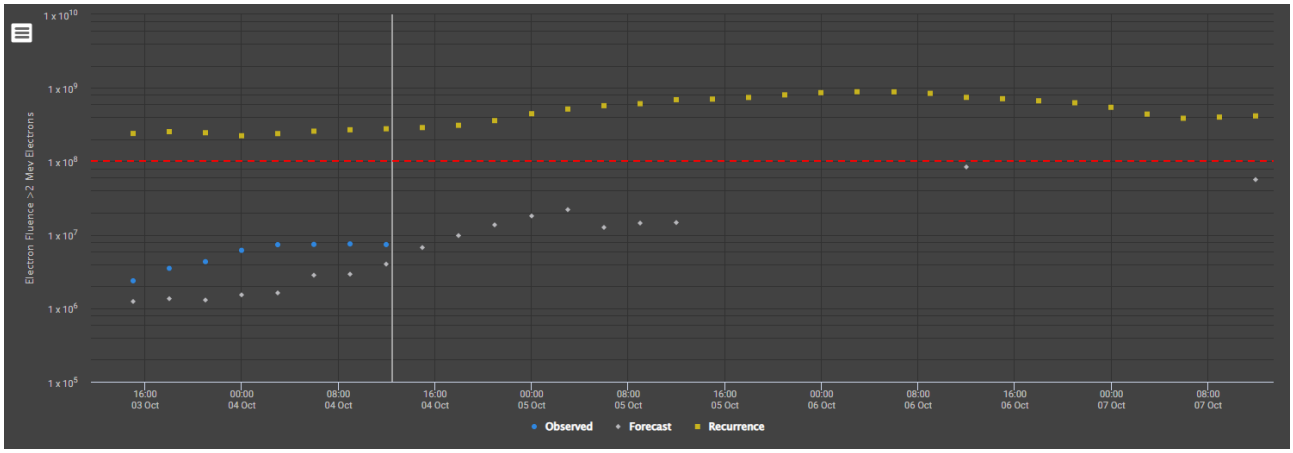
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2MeV) electron flux is likely to rise due to the recent elevated winds. This may occur later day 1 and through the rest of the period, with an increasing chance of flux becoming persistently High. However, this is uncertain due to the recent and potential CME impacts, with any rise likely occurring once their influence subsides.

The associated electron 24 hour fluence is likely to remain below the Active (1e8 integrated pfu) threshold initially, but with a rising trend and with some significant uncertainty due to the CME glances. Should these miss, there is the potential for electron fluence to rise close to, or above, Active by days 3 and 4 (6th and 7th). REFM is currently giving generally good guidance for an upwards trend, but only in the absence of any CME arrival.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	30	60	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	5

Figure 5: REFM Integrated flux/fluence observations, forecast and persistence.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.